

October 10, 2023

Carey Bylin & Matthew Botill
California Air Resources Board

cc: Tyson Eckerle, Governor's Office of Business and Economic Development
Simon Baker, California Public Utilities Commission
David Erne, California Energy Commission

Re: WRI comments on SB 1075 workshop – Priority production and end-use pathways for clean hydrogen in California

Dear Carey and Matt,

Thank you for the opportunity to submit this feedback in relation to the hydrogen development, deployment and use report proceeding. With this short letter, we highlight California's opportunities for clean hydrogen production and consumption as well as consider key deployment considerations related to the 'three pillars' of additionality, deliverability, and hourly matching. This letter draws from the recent *Landscape of Clean Hydrogen: An Outlook for Industrial Hubs in the United States* report co-authored by the World Resources Institute, the Great Plains Institute and Carbon Solutions.¹

In summary, California's high solar potential as well as abundance of annual biomass waste from farms and forests make electrolysis and waste biomass conversion promising production methods. The state's high-electrification ambition and vast agricultural production suggest that end-uses in green fertilizer, energy storage and long-haul freight transport are priority options. Finally, California must work towards assuring that electrolytic hydrogen is truly clean by requiring producers to demonstrate compliance with the three pillars. However, CARB may consider phasing-in these requirements over time (e.g., by 2028) in cases where the green hydrogen would be used in new and priority end-uses. In cases where green hydrogen would replace a non-priority end-use, such as the refining of petroleum fuels, this production should be required to demonstrate compliance with the three pillars from day one.

We hope this letter is useful and we stand ready to answer questions or provide more information

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¹ Abramson, E., McFarlane, D., Jordan, A. et al. (2023). *Landscape of Clean Hydrogen: An Outlook for Industrial Hubs in the United States*. <https://industrialinnovation.org/wp-content/uploads/2023/05/The-Landscape-of-Clean-Hydrogen.pdf>

National clean hydrogen ambition

The Biden Administration has established a major ambition for national clean hydrogen production to reach 10 million metric tons per year by 2030, 20 million tons per year by 2040 and 50 million tons per year by 2050. Currently, around 10 million tons is produced in the U.S. annually. The Regional Hydrogen Hubs program as developed in the Infrastructure Investment and Jobs Act is designed to be a key catalyst of this expansion (Figure 1). The clean hydrogen tax credit (45V) developed in the Inflation Reduction Act will also play a key role in driving production. Overall, there is significant interest for clean hydrogen across the U.S. but the optimal approach to deploying these technologies has not yet been determined.

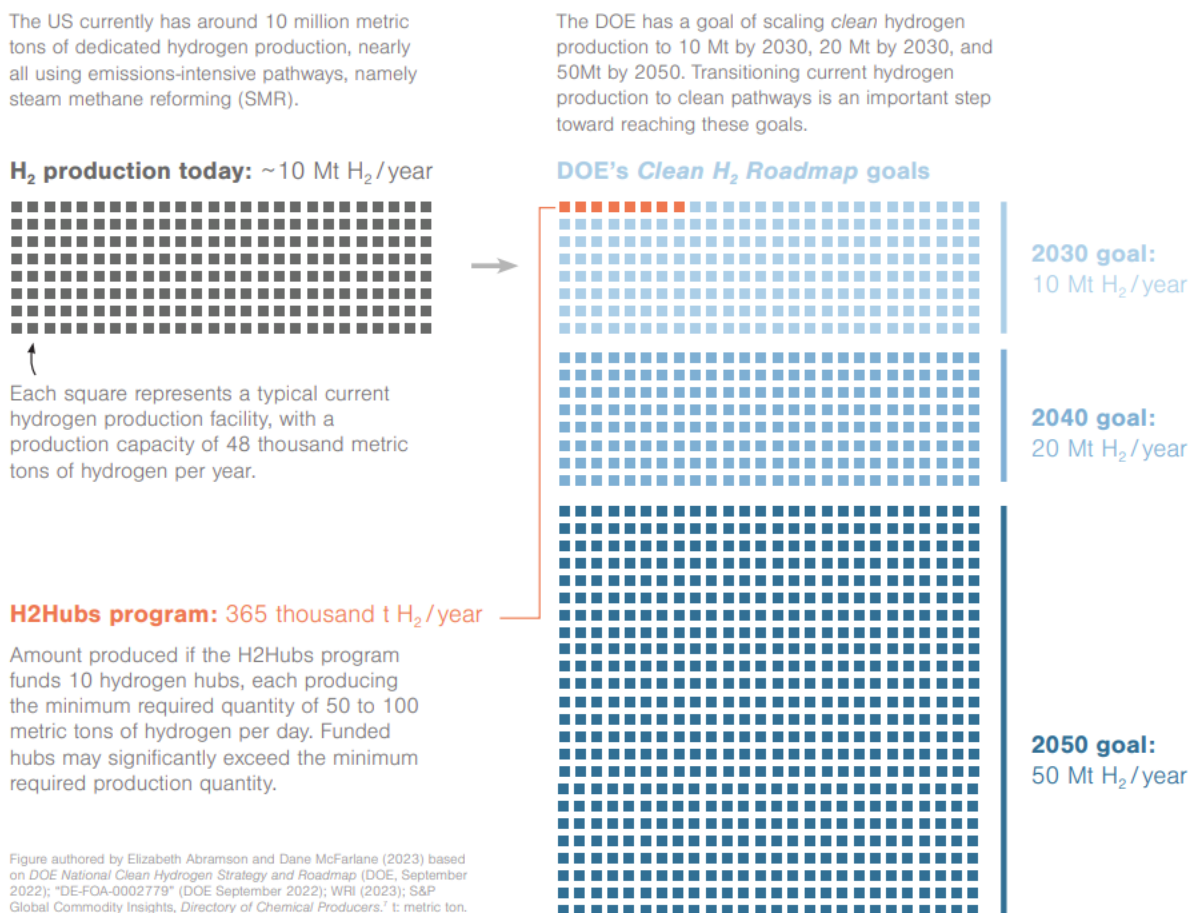


Figure 1. The scale of change needed to achieve DOE clean hydrogen goals.
Source: Landscape of Clean Hydrogen (2023)

Regional approaches to clean hydrogen

Hydrogen is sometimes referred to as the Swiss Army Knife of climate solutions due to its potential to replace fossil fuels in multiple sectors. However, hydrogen is also the lightest and smallest molecule and can leak without specifically designed pipelines and monitoring. This means that, as hydrogen is variously produced, compressed, moved and stored, the risk of leakage— as well as energy used to move

it—rises and can reduce its efficacy as a climate-friendly energy carrier. Minimizing delivery steps is therefore important, underscoring the importance of pairing regional production with priority end-uses. This insight was central to the *Landscape of Clean Hydrogen* report, which sought to assess the clean hydrogen production and consumption potential across the nation on a geographically regional basis. A total of eleven regions were identified across the country based on place-based characteristics including renewable energy availability, industrial infrastructure and alternative end markets (Figure 2).



Figure 2. Strategic opportunities for clean hydrogen production and use by region. Source: *Landscape of Clean Hydrogen* (2023)

For example, the Gulf Coast was identified as having a major refining industry as well as favorable geology for carbon dioxide storage, creating a high potential for clean hydrogen produced via steam methane reformation of natural gas with carbon capture and storage. This clean hydrogen could then be targeted to support the decarbonization of regional chemicals manufacturing. The Upper Midwest’s high wind energy potential could enable significant electrolytic hydrogen production that is then targeted towards green fertilizer for the region’s agricultural industry. The Great Lakes could target clean hydrogen production towards the decarbonization of steelmaking, while the Northeast could swap fossil fuels for clean hydrogen as an alternative source for high-temperature heat in manufacturing.

Like these regions, California has its own place-based opportunities. We identify these in sections below.

California’s clean hydrogen production opportunities

California has promising attributes for supporting two clean hydrogen production pathways, including:

- *Waste biomass.* California has an abundance of biomass waste streams that are otherwise open burned, landfilled or left to decompose in fields causing significant air quality and greenhouse gas emissions in the form of short-lived climate pollutants such as methane and black carbon.² This volume of waste is anticipated to increase substantially, particularly as the state continues to increase its wildfire prevention and forest health treatments.³ This biomass could be converted into hydrogen via multiple technology pathways, such as gasification, pyrolysis and steam methane reformation of biogas. These hydrogen pathways have the potential to be carbon-negative with the addition of carbon capture and storage.
- *Renewable energy.* California’s high solar energy potential makes hydrogen electrolysis a promising production option. Off-grid electrolysis projects could be established throughout the Central Valley, where the Sustainable Groundwater Management Act is already forcing the retirement of tens of thousands of acres of farmland.⁴ Grid-connected electrolysis is a reliable zero-carbon option provided it does not draw renewable resources from the grid in a way that results in increased fossil fuel combustion. This is discussed in more detail below.

California’s clean hydrogen consumption opportunities

A selection of priority end-uses for clean hydrogen in California can also be identified, including:

- *Long-duration storage.* California’s high renewable electricity goals increase the need for long-duration energy storage options to combat intermittency challenges.⁵ During periods of low energy demand, excess electricity supply can be used to produce clean hydrogen that is stored in large quantities in caverns, depleted oil fields and aquifers. This could provide a ‘firming’ option during periods of high energy demand and low renewable capacity. Hydrogen produced via electrolysis could also help to avoid an overreliance on natural gas peaking plants during extreme weather events.
- *Transportation fuels.* Clean hydrogen can act as a feedstock in the production of drop-in renewable fuels for use in freight transport and sustainable aviation. California could progressively transition its major refining industry to support clean transportation fuels production. Biofuel production can also be paired with carbon capture and storage to create carbon-negative fuels. This is a promising option for California as the state is anticipated to need

² California Infrastructure and Economic Development Bank. (2022). Sustainable woody biomass industry development in California. <https://business.ca.gov/wp-content/uploads/2022/02/GO-Biz-Interagency-Biomass-Market-Development-Framework.pdf>

³ California Air Resources Board. December 2022. Final 2022 Scoping Plan for Achieving Carbon Neutrality. <https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp.pdf>

⁴ Ayres, A., Rosser, A., Hanak, E. et al. (2022). Solar energy and groundwater in the San Joaquin Valley – how policy alignment can support the regional economy. <https://www.ppic.org/publication/solar-energy-and-groundwater-in-the-san-joaquin-valley/>

⁵ Legislative Analyst’s Office. (2023). Proposed energy policy changes in the FY23/24 state budget. <https://lao.ca.gov/Publications/Report/4735>

nearly 75 million tons of technological carbon dioxide removal, including via direct air capture and bioenergy with CCS, to meet its carbon neutrality by 2045 goal.⁶

- *Fertilizer production.* California's extensive agricultural industry is a significant consumer of synthetic fertilizer. However, over 90% of this fertilizer is imported, including a potentially sizeable amount from Russia.^{7,8} There is a compelling opportunity for California to drive part of its merchant clean hydrogen production towards a new clean fertilizer industry. This can create rural jobs and limit the state's exposure to potential new geopolitical crises in the future.

Addressing the 'three pillars' for green hydrogen

A key issue faced by clean hydrogen proponents is how to ensure that hydrogen produced via electrolysis ('green' hydrogen) actually uses renewable energy. There is a risk that grid-connected electrolysis projects will draw clean energy from the grid and result in increased fossil fuel combustion. This issue has been central to considerations around implementation of the 45V tax credit by the Internal Revenue Service as well as a topic of discussion amongst California stakeholders.^{9,10,11,12,13}

Proposals have identified three requirements (or 'pillars') which could address this issue, including: (i) *additionality* – only newly developed clean electricity resources, not already serving the grid, can qualify as clean supply for electrolyzer loads; (ii) *deliverability* – electrolyzer loads must have ready or reliable access to a clean electricity resource, preferably in the same region; and (iii) *hourly-matching* – electrolyzer loads must match clean electricity portfolio production in every hour. Meeting all three requirements can ensure that hydrogen produced from electrolysis is truly zero-carbon.¹⁴

Ensuring that the three pillars are ultimately met for all green hydrogen production is necessary as part of a credible emissions reduction program. However, given the additional burden of meeting these

⁶ Conservation Strategy Group. (2022). Final Scoping Plan identifies key role for carbon dioxide removal. <https://www.csgcalifornia.com/blog/final-scoping-plan-identifies-key-role-for-carbon-dioxide-removal/>;

⁷ Eric Johnson. (2021). How the Port of Stockton connects the Central Valley to the world.

<https://www.comstocksmag.com/qa/how-port-stockton-connects-central-valley-world#:~:text=The%20Port%20of%20Stockton%20provides,to%20fulfill%20the%20domestic%20need>

⁸ Brittany Johnson. (2022). Fertilizer prices are skyrocketing for California Central Valley farmers. Here's why it matters. <https://www.kcra.com/article/fertilizer-prices-are-skyrocketing-for-california-central-valley-farmers-heres-why-it-matters/40592798#>

⁹ U.S. Department of Treasury and Internal Revenue Service request for comments on credits for clean hydrogen and clean fuel production. (2022). Notice 2022-58. <https://www.irs.gov/pub/irs-drop/n-22-58.pdf>

¹⁰ Joint letter from Clean Air Task Force, Environmental Defense Fund and others to the U.S. Treasury on implementation of the IRA 45V clean hydrogen tax credits. (2023). <https://www.nrdc.org/sites/default/files/2023-03/joint-letter-45v-implementation-20230223.pdf>

¹¹ Letter from the Alliance for Renewable Clean Hydrogen Energy Systems, California Governor's Office of Business & Economic Development and the State Building and Construction Trades Council of California to the U.S. Treasury. (2023).

<https://www.politico.com/f/?id=0000018a-6cd6-dd5e-abfe-efd6906c0000&nname=california-climate&nid=00000189-315c-d8dd-a1ed-797dc9f10000&nrid=ad1ab22e-203c-479d-8d76-dd580beb334e&nlid=2745178>

¹² Dan Esposito et al. 2023. Smart design of 45V hydrogen production tax credit will reduce emissions and grow the industry. <https://energyinnovation.org/wp-content/uploads/2023/04/Smart-Design-Of-45V-Hydrogen-Production-Tax-Credit-Will-Reduce-Emissions-And-Grow-The-Industry.pdf>

¹³ Letter from University of California academics to Governor Newsom and UC President Michael Drake. (2023). <https://www.politico.com/f/?id=0000018a-9b1f-d776-a3ce-fff49d30000>

¹⁴ Wilson Ricks et al (2023) *Environ. Res. Lett.* **18** 014025. Minimizing emissions from grid-based hydrogen production in the United States. <https://iopscience.iop.org/article/10.1088/1748-9326/acacb5/meta#erlacacb5s3-1>

requirements, which could actually inhibit the development of the ‘new’ hydrogen economy needed to meet an economywide net-zero emissions target, we suggest that CARB consider a phased-in approach for certain green hydrogen production-consumption pathways. For example, for grid-connected green hydrogen that has an offtake for a priority end-use that the state is seeking to expand, such as a feedstock for renewable fuels, this green hydrogen production could be exempt from demonstrating requirements until 2028. This can provide an incentive for the expansion of these markets and priority buyer-seller relationships. Considering California's stated goals and momentum towards decarbonizing its electricity grid, new hydrogen projects in priority-end uses could develop simultaneously with power-sector emission reductions before the phase-in. However, for grid-connected green hydrogen that has an offtake for a non-priority end-use, such as petroleum refining, this clean hydrogen production would not receive the exemption and should be required to demonstrate compliance with the three pillars from day one.

As key California stakeholders appear to be split on this issue,^{15,16} we hope that this suggestion is useful to CARB and can support progress in grid-connected green hydrogen production in the state.

Conclusion

Clean hydrogen can play a key role in California’s path to net-zero emissions. However, this depends on multiple factors including how it’s produced, transported, and consumed. California is well-placed to lead on electrolytic and waste biomass hydrogen production, which makes sense to target largely towards long-duration storage, transportation fuels and fertilizer production. Forthcoming plans should consider that although hydrogen has the benefit of being versatile, this benefit can decline rapidly due to inefficient transportation and/or leakage. Finally, California must aim to require that grid-connected green hydrogen production meets the three pillars of additionality, deliverability and hourly-matching. However, given the additional constraints this could put on a nascent but important industry it may make sense to phase-in these requirements over time for where the green hydrogen is consumed as part of a priority end-use.

¹⁵ Letter from University of California academics to Governor Newsom and UC President Michael Drake. (2023). <https://www.politico.com/f/?id=0000018a-9b1f-d776-a3ce-fff49d30000>

¹⁶ Letter from the Alliance for Renewable Clean Hydrogen Energy Systems, California Governor’s Office of Business & Economic Development and the State Building and Construction Trades Council of California to the U.S. Treasury. (2023). <https://www.politico.com/f/?id=0000018a-6cd6-dd5e-abfe-efd6906c0000&nname=california-climate&nid=00000189-315c-d8dd-a1ed-797dc9f10000&nrid=ad1ab22e-203c-479d-8d76-dd580beb334e&nlid=2745178>